

ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

ORIGINAL
FILE

In the Matter Of:

Mobile Telecommunication
Technologies Corporation

Request for a Pioneer's Preference
Regarding its Petition for Rulemaking
to Allocate Three 50 kHz Channels in the
930-931 MHz Band and to Establish Rules and
Policies for a New Nationwide Wireless
Network (NWN) Service

ET Docket No. 92-100
PP-37

RECEIVED
JUN 16 1992

REPLY COMMENTS

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

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TECHNOLOGIES CORPORATION

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REPLY COMMENTS

Mobile Telecommunications Technologies Corporation ("Mtel"), by its attorneys, herewith submits its reply to comments filed concerning its above-captioned request for a Pioneer Preference.¹ As detailed below, only two parties filed substantive comments in opposition to Mtel's proposal.² In both cases, they reflect a fundamental misstatement of Mtel's proposed Nationwide Wireless Network Service ("NWN") and a fundamental misunderstanding of its technological foundations. The record clearly confirms that NWN represents an enormous leap forward in advanced messaging capabilities for the country.³

¹ See Deadline To File Pioneer's Preference Requests 900 MHz Narrowband Data and Paging Service (ET Docket No. 92-100), *Public Notice*, Mimeo 22922 (April 30, 1992).

² *Comments of PageMart, Inc.*, ET Docket No. 92-100, RM-7679 *et al.* (filed June 1, 1992) ["*PageMart Comments*"]; *Comments of Paging Network, Inc.*, ET Docket No. 92-100, PP-35 *et al.* (filed June 1, 1992) ["*PageNet Comments*"]. A third party, VISA, filed comments supporting Mtel's proposed NWN service.

³ *Mobile Telecommunication Technologies Corporation Request for a Pioneer's Preference Regarding its Petition for Rulemaking to Allocate 150 kHz in the 930-931 MHz Band and to Establish Rules and Policies for a New Nationwide Wireless Network (NWN) Service*, ET Docket No. 92-100, PP-37 (filed November 21, 1991) ["*NWN Preference Request*"]. See also *Mobile Telecommunication Technologies Corporation Petition for Rulemaking to Allocate 150 kHz in the 930-931 MHz Band and to Establish Rules and Policies for a New*

I. INTRODUCTION

Mtel's proposed Nationwide Wireless Network service transcends existing technological limitations to introduce the next generation of advanced messaging services. Today's paging services provide important, economical and highly useful one-way services. However, they operate at low speeds typically (1200 bps) and cannot support interactive delivery of data or information to persons or computers. Tomorrow's NWN would shatter these constraints.

As documented in the *Mtel Pioneer Preference Request* and the *Mtel Technical Feasibility Demonstration*, NWN will provide consumers with several critical breakthroughs in messaging capabilities:

- **Speed.** NWN will support high speed 24,000 bps messaging, a data rate twenty times that of most existing paging systems and ten times that of the world's fastest commercially available service -- Mtel's 2400 bps SkyTel service.
- **Capacity.** NWN can serve from 600,000 to 800,000 subscribers initially and its capacity can be increased in response to market demand.
- **Two-Way Functionality.** NWN will support user defined levels of two-way functionality from simple acknowledgements to two-way transfer of digital data.
- **Nationwide Coverage.** NWN will serve subscribers on a nationwide basis.⁴

Nationwide Wireless Network (NWN) Service, ET Docket No. 92-100, RM-7978 (filed November 21, 1991) (proposing to allocate three 50 kHz channels for competitive NWN carriers) ["*NWN Petition*"]; *Mobile Telecommunication Technologies Corporation Technical Feasibility Demonstration on its Request for a Pioneer's Preference Regarding its Petition for Rulemaking to Allocate 150 kHz in the 930-931 MHz Band and to Establish Rules and Policies for a New Nationwide Wireless Network (NWN) Service*, ET Docket No. 92-100, PP-37 (filed June 1, 1992) ["*NWN Technical Feasibility Demonstration*"].

⁴ Where appropriate, coverage of remote areas can be secured through hand-off to American Mobile Satellite Corporation's satellite delivery system.

- ***Application Independence.*** NWN offers an application independent digital data transmission service that can be customized for each user's requirements.
- ***Adaptable Functionality.*** NWN supports variable levels of error detection and correction capability, as well as encryption, prioritization, and many billing options depending upon each end user's requirements.
- ***Support for Industry Standards and Customized Needs.*** Interfaces supporting numerous industry standards are planned to allow the broadest compatibility between NWN and wireline messaging systems. Specialized arrangements will also be available to support specific needs for customers.

Thus, NWN offers unprecedented advances in messaging capabilities coupled with nationwide two-way functionality.

In response to Mtel's submissions, the Commission received opposing comments from just two companies -- PageMart, Inc. ("PageMart") and Paging Network, Inc. ("PageNet"). PageMart and PageNet collectively cite four purported deficiencies in the NWN Pioneer Preference Request: (1) the proposal is not innovative because high speed data transmission capabilities are already theoretically possible; (2) NWN is not spectrally efficient and will face serious capacity limitations in comparison with local paging or messaging services; (3) NWN mobiles will be large and expensive with extremely short battery life; and, (4) NWN could be deployed in other spectrum or through other services more effectively.

II. SUMMARY

As petitioners seeking virtually the entire 930-931 MHz for their own parochial services, PageMart and PageNet have attacked other system proponents for that band, including Mtel. However, their challenges to NWN are ill-founded and misguided in the following respects:

Innovation. PageMart insists that NWN's 3,000 baud and 24,000 bps data rates are not innovative because higher baud and bit rates are theoretically possible.⁵ However, NWN's 24,000 bps data rate is twenty times the highest speed of typical paging systems in operation today and ten times the speed of the fastest commercially available service in the world -- Mtel's SkyTel™ Service. In contrast, PageMart's own "innovative " service contemplates only a 4800 bps data speed. And, with respect to baud rates, NWN would be significantly higher than SkyTel™'s 2,400 baud, which is also the fastest existing commercial simulcast system in terms of baud rate.

Capacity and Spectrum Efficiency. PageMart and PageNet expend considerable energies purportedly demonstrating the "limited" capacity of NWN to meet subscriber needs. Mtel's Technical Feasibility Demonstration, on the other hand, shows that NWN is a landmark breakthrough which effectively integrates frequency re-use into a nationwide simulcast service. Consequently, NWN can support 600,000 to 800,000 subscribers with ample ability to expand capacity as needed. Furthermore, Mtel's proposed service is 2.7 times more spectrally efficient than PageMart's proposed "Personal Information Messaging Service" ("PIMS") while Paging Network, Inc.'s proposed VoiceNow service would consume a full 50 kHz just to handle signalling and control for its limited one-way voice paging system.

⁵ The baud rate differs from the bit rate in that the baud rate specifies the rate at which symbols can be transmitted, and the bit rate specifies the throughput achieved by decoding the symbols into a binary stream.

Indeed, Mtel used MPR Teletech Ltd ("MPR") to model an NWN system and a PIMS system utilizing Mtel's more realistic traffic estimates.⁶ MPR's calculations indicate that, based on the "polling channel" capacity of the PIMS system in an MSA, the PIMS system could support only 46,161 subscribers. MPR noted, however, that the PIMS "return link protocol design is in error and cannot support the maximum poll channel transaction rate, and in fact, may limit the transaction rate to less than half."⁷ Limiting the number of transaction by half, of course, would have the PIMS capacity to 23,080 subscribers per MSA. In contrast, one zone in a 24,000 bps NWN system, which could be a single MSA, can support 22,900 subscribers, *in one-fifth the amount of spectrum*.⁸

Mobile Size, Cost and Battery Life. Mtel intends to use portables operating at 2 watts or less in its NWN system, not 7 watts as assumed by PageMart. As fully documented in the *Mtel Technical Feasibility Demonstration*, Mtel's NWN portables will be small and low cost with extended battery life.

Other Spectrum or Services. PageNet, for its part, asserts that Mtel could deploy NWN at 220 MHz, in Mtel's existing nationwide system or through cellular and SMR carriers. The channelization plans at 220 MHz (5 kHz) and 931 MHz (25 kHz) quickly

⁶ MPR has research and development roots extending over 80 years through its predecessor, GTE Lenkurt Electric (Canada) Ltd. MPR's extensive experience covers a broad range of technologies and services, including: (1) microwave radio, satellite, emergency, aeronautical, and infrared communications; (2) network management, supervisory and signalling, and imaging systems; (3) systems integration; and (4) manufacturing. MPR has recently been engaged in performing in-depth studies on the performance of wireless technologies for its parent, BC Tel, including cellular CDMA, cellular TDMA, CT-2+, and other new mobile data technologies. MPR's calculations are attached as Exhibit B, "Comparison of Maximum capacity of PageMart and Mtel Messaging Services."

⁷ Exhibit B at 2.

⁸ Exhibit B at 2-3.

dispose of the alternative spectrum home claim. Furthermore, cellular and SMRs are designed as real-time, interactive voice or data telecommunications rather than data messaging. NWN will complement, but not compete with such offerings.

Finally, NWN is an inherently nationwide service designed for and responding to consumer needs for nationwide coverage. A preliminary study prepared by Arthur D. Little identifies three tentative assessments of demand for NWN:

- 1) Over the next few years NWN offerings have the potential to garner a significant share of an addressable market of 2.7 million users;
- 2) Nationwide rather than regional or local services are likely to be preferred by business travelers and by those who use laptop/palm top PCs and electronic organizers; and
- 3) Mobile messaging activity is likely to involve relatively short messages (one or two pages of about 2,000 bytes each) rather than file transfers of more lengthy documents.

These findings corroborate Mtel's assumption about the need for the innovative NWN service.

III. MTEL'S NWN SERVICE IS HIGHLY INNOVATIVE

Mtel's NWN system pioneers the use of enhanced multitone modulation techniques to achieve simulcast bit rates as high as 24,000 bits per second. This bit rate is twenty times conventional paging systems and ten times faster than the current state-of-the-art system recently implemented by Mtel. NWN's improvement over existing systems required Mtel to develop high dimensionality, simulcast-compatible signalling techniques due to the 3,000 baud practical limitation on simulcast systems.⁹ As discussed in the *Mtel Technical Feasibility Demonstration*, these techniques have been thoroughly proven out in computer modeling and are currently the subject of ongoing field tests.

PageMart discounts accomplishment of 24,000 bps because "engineers at Matsushita Electric Company in 1980 developed a modulation scheme that had an effective data rate of 16,000 bps in a 25 kHz channel."¹⁰ Later, in an exercise of pure sophistry, PageMart cites the inability of such modulation schemes to be deployed effectively as demonstrating that NWN is not feasible.¹¹ What PageMart fails to grasp is that Mtel's technological

⁹ The baud rate differs from the bit rate in that the baud rate specifies the rate at which symbols can be transmitted, and the bit rate specifies the throughput achieved by decoding the symbols into a binary stream.

In this regard, PageMart's repeated assertions that Mtel has neglected the "spatial" component in describing its forward channel as having a spectral efficiency of 0.48 bps/Hertz is inapposite. The number of bits transmitted is a valid measure of the efficiency of a modulation scheme, and indeed, is used by the Commission for microwave systems. See 47 C.F.R. § 21.122(e) (1991) (requiring a spectral efficiency over 1.0 bps/Hertz).

¹⁰ *PageMart Comments* at 56-57.

¹¹ *PageMart Comments* at 58.

innovations make theoretical high speed data rates possible for the first time in a technically and commercially viable system.¹²

PageMart also criticizes NWN's use of 3,000 baud simulcasting because "Motorola, Quintron and Complex Systems can control time shifts down to 1 to 5 microseconds which allows baud rates up to 9,600."¹³ PageMart fails to disclose that such baud rates are for fixed -- not mobile -- service applications. Moreover, its simplistic contentions fail to recognize that timing shifts are not the only source of asynchronicity in a simulcast system; propagation anomalies caused by terrain conditions and mobile users cannot be engineered out of a transmitter.¹⁴ In fact, an analysis of terrain induced propagation anomalies conducted for Mtel concluded that a simulcast system should be robust enough to overcome propagation delays on the order of 83 μ sec.¹⁵ When added to the 1-5 μ sec timing delays in state-of-the-art transmitters, the total delays approximate Mtel's practical limitation of 3,000 baud.¹⁶

¹² In any event, Mtel has provided a simple forward evolutionary path to ensure that if these more complex modulations prove out, they can be incorporated into the Mtel NWN network. *Mtel Technical Feasibility Demonstration* at 29. At this time, however, Mtel believes that no higher dimensionality signal can be demonstrated that offers comparable simulcast robustness and comparable cost in end-user receivers -- both in terms of price and battery drain.

¹³ *PageMart Comments* at 64.

¹⁴ *Mtel Petition* at B3-B4. While some effects of propagation anomalies can be overcome by placing the transmitters extremely close together, this "solution" would require enormous infrastructure costs that are fundamentally inconsistent with attempting to provide low-cost services.

¹⁵ MPR was retained by Mtel to evaluate the NWN service proposal. See *Mtel Formal Opposition and Reply Comments* Exhibit A at 26, ET Docket 92-100, PP-40 (filed June 16, 1992).

¹⁶ This is, incidentally, why PageMart will not be able to increase the speed of its system to 9,600 or 12,000 baud. See *Mtel Formal Opposition and Reply Comments* Exhibit A at 26, ET Docket No. 92-100, PP-40 (filed June 16, 1992). Mtel's original statement on this matter also is confirmed by the results of the PacTel Paging tests. See PacTel Paging, Inc. Interim Test Report, KF2XFD, File No. S-0365-EX-91 (filed April 16, 1992).

IV. MTEL'S NWN SERVICE UTILIZES INNOVATIVE FREQUENCY MANAGEMENT TECHNIQUES TO ACHIEVE HIGH CAPACITY AND SUPERIOR SPECTRUM EFFICIENCY

Mtel has relied on several innovative technologies to create a high capacity spectrally efficient messaging service. As discussed below, Mtel's research efforts have yielded several advances over current wireless messaging technology. In addition to developing a simulcast compatible modulation scheme using multiple tones, Mtel also developed a number of other innovations collectively forming its Advanced Dynamic Frequency Management ("ADFM") scheme. ADFM maximizes use of the modest spectrum requested for NWN. The fruits of Mtel's research program, individually and collectively, form the technical basis for Mtel's requested pioneer's preference.

PageMart and PageNet labor hard to fault NWN's capacity and spectrum efficiency. With respect to system capacity, they incorrectly assert that (1) NWN's capacity is extremely limited; (2) NWN's 34 zone system cannot be expanded; (3) frequency re-use is not possible; (4) interzone interference will limit the ability to add capacity; and, (5) that NWN cannot match conventional local paging systems or their own proposed local services in spectrum efficiency. Each of these contentions is quickly and readily addressed below.

A. Mtel's Advanced Dynamic Frequency Management Scheme Offers Heretofore Unachieved Levels of Capacity and Spectral Efficiency

PageMart and PageNet fail to recognize that NWN is a unique and innovative integration of nationwide simulcasting capabilities with frequency re-use techniques. As documented previously, NWN will deploy an innovative Advanced Dynamic Frequency

Management ("ADFM") scheme to optimize efficient spectrum usage. The ADFM protocols will implement a number of important features, including:

- ***Dynamic Zoning for Forward Channel Frequency Re-Use.*** NWN combines both re-use and simulcast operation to obtain the maximum capacity, and thus provide superior spectral efficiency as compared to either cell-based re-use or simulcast utilized alone. In effect, NWN forward channel transmissions are divided into nationwide and zonal batches. As a precious resource, nationwide packets are used efficiently -- as necessary to locate portables that have changed zones and to deliver traffic to portables that are between zones. Using this scheme, the NWN system can easily combat saturation by shifting zone boundaries or creating additional zones by changing the signals relayed by a set of transmitters during the zonal portions of the cycle.
- ***Multiple Receiver Load Balancing for Reverse Channel Frequency Re-Use.*** NWN's independent simultaneous use of the multiple receivers in each zone significantly increases the reverse channel capacity of the NWN system. NWN requires a high density of reverse channel receivers to compensate for the low ERP of portable terminals (*e.g.*, on the order of 4 to 20 times more base station receivers than transmitters), but NWN uses each receiver independent of any particular transmitter, zone, or region.
- ***Comprehensive Dynamic Scheduling.*** Allowing all of the components of the forward and reverse cycles to be dynamically varied, on a zone-by-zone and cycle-by-cycle basis, insures spectrally efficient use of available capacity. Within a single channel, the NWN multiplexes a number of uses, including the nationwide/zonal split; the forward/reverse division; the 64 forward channel address batches; and, finally, the reverse channel division between the CPODA reservations and the scheduled responses. All of these divisions are dynamically scheduled, so that no capacity is wasted.¹⁷

¹⁷ Mtel's NWN system uses variable batch lengths to increase overall throughput. As discussed in the *Mtel Technical Feasibility Demonstration*, this necessitates an "on-duty" cycle of only 0.28% for NWN portables, which can be compared to the 18.0% used by the POCSAG formats PageMart has chosen. See *Mtel Technical Feasibility Demonstration* at 18 & B19, ET Docket 92-100, PP-37 (filed June 1, 1992). And, while ERMES does have a slightly lower "on-duty" cycle (0.10%), Mtel's ability to vary batch loading dynamically, which ERMES cannot do, allows NWN to make far more efficient use of the allocated spectrum. As explained in the original *Mtel Petition*, failing to allow for variable batch lengths requires ERMES to "pad out" batches to achieve uniform batch lengths. Thus, variable batching plainly increases, not wastes, available air time. Consequently, PageMart's argument that NWN will entail wasted airtime and add to terminal complexity "by sending instructions as to when to expect message reception," faults one half of a necessary trade-off to increase spectrum efficiency. *PageMart Comments* at 67.

- **Contention Priority Ordered Demand Assignment ("CPODA") Reverse Channel Resource Allocation.** Mtel developed a variant of Contention Priority Oriented Demand Assignment ("CPODA") for NWN. Mtel's customized version of CPODA has the reservation carry a description of traffic the portable wishes to transmit, so that the central scheduler can optimize the reverse channel assignment and not require packet-by-packet use of the reservation sub-channel. Slotted ALOHA is used, but only to gain access, however, and the bulk transfer of data occurs under central scheduling to increase overall efficiency. By limiting the random access reservations to a portion of the cycle and keeping that portion as small as possible, NWN insures that the reservations do not collide with scheduled traffic. Therefore, the useful throughput of the scheduled traffic portions of the cycle is 92% of the allocated capacity.
- **Adaptive Registration.** Mtel has developed and refined the concept of a protocol for "adaptive registration," which will provide NWN the ability to change the registration capability of a given portable dynamically, over the air, based on usage patterns. Portables that have generated a number of registrations during a period within which they have not received messages are commanded to the non-registration mode. Portables that have required several nationwide searches are commanded to the registration mode. Thus, even for subscriber location determination, Mtel has optimized NWN's spectrum use.

The high speed forward channel transmission scheme and centralized Intelligent Network optimize channel usage by portables and base stations to efficiently utilize spectrum. The same features also extend battery life, thereby enhancing the utility of the service.

B. PageMart and PageNet's Criticisms of NWN Misstate and Mischaracterize the Record

In their efforts to belittle Mtel's accomplishments, PageMart and PageNet insist that NWN's innovations are either mundane,¹⁸ irrelevant,¹⁹ specious,²⁰ or unverified. These

¹⁸ PageNet, for example, pursues strawman arguments stating, for example, that "[s]imulcasting is not a new technology." *PageNet Comments* at 13. Mtel has not maintained that simulcasting is an innovation. The relevant claim is that a technically feasible simulcast system like NWN employing a comprehensive frequency management scheme and operating at a high bit rate far in excess of current systems is innovative.

contentions are simply wrong. They reflect a misstatement or mischaracterization of NWN's true potential in the following respects:

System Capacity. PageMart claims that NWN's system capacity is extremely limited. Its analysis of NWN, however, is based upon a scenario involving peak busy hours in one of the nation's largest cities assuming unsubstantiated lengthy messages. Mtel, in contrast, has fully documented that NWN can initially support 600,000 to 800,000 subscribers nationwide under reasonable message length assumptions (an average of 3,000 characters per message). Moreover, as explained below, NWN capacity can be increased by adding zones.

Frequency Re-Use. Contrary to PageMart's assertions,²¹ NWN employs extensive forward channel and reverse channel frequency re-use. Because the large majority of all forward channel traffic is transmitted on zonal time slots, the forward channel re-use capacity of Mtel's system rises almost linearly on a one-to-one slope with the number of zones. NWN also schedules reverse channel transmissions on each receiver individually taking advantage of NWN's automatic subscriber location capability and the statistical geographic dispersion of subscribers, achieving highly efficient reverse channel re-use of frequencies.

¹⁹ PageMart states, for example, that "nationwide simulcasting is the most spectrum inefficient approach possible." This ignores the fact that NWN's innovations allow for the integration of spectrum re-use and zonal simulcasting in a highly efficient system. *PageMart Comments* at 57.

²⁰ PageMart states at one point, for example, that "[f]rom a system engineering standpoint, NWN is similar in concept to many CT-2 approaches that use time division duplex. . ." *PageMart Comments* at 55. Other than the use of time division duplex, NWN bears absolutely no relation to CT-2. CT-2 is voice, originate-only, and real-time. NWN is data, fully two-way, and store-and-forward.

²¹ PageMart and PageNet insist that Mtel does not employ frequency re-use on the apparent misguided belief that "re-use" can only occur through "cell-based" techniques they have advocated. *PageMart Comments* at 63. *PageNet Comments* at 13.

This ability to re-use a single frequency is a major innovation that permits a high level of spectrum efficiency.²²

Ability to Expand Capacity. PageMart assumes that the 34 zone NWN configuration described in the *Mtel Petition* represents the outer limits of system capacity. Without belaboring the point, the 34 zones do not represent any absolute limit on potential spectrum re-use. One of the attractive features of Mtel's approach is the ability to add zones and capacity in response to subscriber needs.

Interzone Interference. PageMart cites interzone interference as limiting NWN capacity. As discussed in the *Mtel Technical Feasibility Demonstration* and the *Mtel Petition*, however, there are a number of means of controlling interzone interference and conserving use of the nationwide resources in order to enhance the capacity of a nationwide system. First, the system can be engineered so that interzone overlaps fall on areas of lower traffic density.²³ Thus, by judicious selection of where to locate zone boundaries, Mtel can

²² PageMart has stated, because "the critical return link receiver is not one station transmitting and receiving, but rather a network of receivers which may be dispersed within a major urban area," that "flow and error control of transmission is not achievable per standard data transmission requirements." *PageMart Comments* at 55. PageMart's inability to visualize an error control scheme that does not require co-located transmitters and receivers is puzzling. Packets will flow from the base station transmitters, be received by the NWN portable, which will acknowledge on the receiver network. The central controller will be able to match acknowledgements to packets transmitted, and perform any necessary retransmissions. There is absolutely no reason to require any co-location whatsoever.

Furthermore, as discussed in Mtel's opposition to PageMart's pioneer preference request, PageMart will be required to do exactly the same thing, since its base transmitters will have a much greater service area than the mobile transmitter. *See Mtel Formal Opposition and Reply Comments* at 4 & A11-A14, ET Docket 92-100, PP-40 (filed June 16, 1992). One difference between the two systems, however, is that NWN treats each receiver as independent, allowing it to schedule multiple simultaneous reverse channel transmissions on different receivers. PageMart makes no provision for fully utilizing the 169 estimated receiver sites associated with a cell, which is highly inefficient because 169 receivers will only be utilized to pick up only two transmissions at any given time. *Id.*

²³ *Mtel Petition* at A10-A12; *Mtel Technical Feasibility Demonstration* at 12 n.31.

control the need for use of nationwide time slots. Second, NWN can take advantage of terrain features and the use of directional antennas to further minimize interzone interference.²⁴ Finally, Mtel's dynamic zone allocation will allow Mtel to deliver message traffic to users between zones without use of nationwide slots.²⁵ Dynamic zone allocation can, in fact, be used to develop zones within metropolitan areas. Plainly, PageMart's repeated criticisms of Mtel's adaptive zoning scheme -- that interzone interference will limit Mtel's ability to zone for added capacity because more traffic will be required to be carried on the nationwide time slots -- ignores the realities of Mtel's NWN system as documented.²⁶

Comparing Nationwide and Local Services. PageMart and PageNet engage in a comparison of NWN capacity with the capacity of conventional local paging systems. This, of course, is an apples and oranges comparison. Local paging systems need only be designed to maximize service to local customers. In contrast NWN is fundamentally designed as a nationwide system serving the needs of subscribers who require ubiquitous data transfer capability across the United States. With these markedly different service objectives,

²⁴ *Id.*

²⁵ *Mtel Technical Feasibility Demonstration* at 12 n.31 & D18. Importantly, dynamic zone allocation will not eliminate the need for nationwide time slots, however, because nationwide messaging is still necessary to locate subscribers changing zones.

²⁶ *PageMart Comments* at 46-47, 50, 54, 59, and 65-67. PageNet also criticizes the adaptive zoning scheme, but paradoxically as "not unique," stating that PageNet "currently employs similar zoning techniques throughout its nationwide paging system." *PageNet Comments* at 13. While it may be true that PageNet utilizes a technique that could be described as "zoning," Mtel's particular adaptive zoning scheme is unique. No existing system, to Mtel's knowledge, utilizes such a refined mechanism for maximizing capacity, including the ability to reconfigure zones in real time.

local paging companies clearly can serve more customers in a given local market. Just as clearly, they cannot provide ubiquitous nationwide coverage.

Comparing NWN with PageMart and PageNet's Proposals. PageMart and PageNet have disingenuously taken Mtel's original capacity estimates for a "mature, but not fully developed" NWN system as the maximum capacity of the system. When realistic capacity estimates are used, the local capacity and efficiency of NWN is actually far better than Personal Information Messaging Service ("PIMS"). First, over 80% of PIMS capacity is derived from "building" and "office" cells. As Mtel discusses in its opposition and reply comments directed at the *PageMart Pioneer Preference Request*, this microcellular architecture is fundamentally technically flawed and the market for such services, to the extent it exists at all, can be satisfied using faster, cheaper, and more flexible alternatives.²⁷ When PageMart's unworkable "in-building" capacity is removed, it can be shown that the "data channel" capacity of a 40 cell system is less than 34,000 subscribers per MSA and that the "polling channel" capacity of a PIMS system is 12,000 subscribers per MSA.²⁸ Unfortunately, the paucity of information on the "return link" precludes identifying exactly its capacity, although it appears to be approximately half that of the polling channel. And, for both PageMart's PIMS service and PageNet's VoiceNow service, a full 50 kHz -- the entire spectrum required to implement NWN -- is used solely for signaling.

²⁷ See *Mtel Formal Opposition and Reply Comments* at 14, ET Docket No. 92-100, PP-40 (filed June 16, 1992).

²⁸ *Mtel Formal Opposition and Reply Comments* Exhibit B at 4-6, ET Docket 92-100, PP-40 (filed June 16, 1992).

When these more realistic capacity estimates are used to evaluate spectral efficiency, PIMS is clearly less efficient than NWN. Assuming PageMart's traffic model of 6000 character messages and 2.5 messages per subscriber in a 10 hour period, and balanced forward and reverse traffic, MPR calculated that a 24,000 bps NWN system operating with one MSA zone had 2.7 times the spectral efficiency of a 40 cell, 4800 bps PIMS system with a polling channel capacity of 12,000 subscribers. NWN's effective capacity within the MSA, of course, could be increased through subzoning, whereas for PIMS, the lack of additional polling channel capacity precludes further capacity enhancement through re-use.

* * * *

The foregoing demonstrates the benefits of designing a wireless messaging system from the ground up, rather than attempting to adapt a technology for a use it was not intended to serve. By designing NWN as a nationwide messaging system, Mtel has pioneered a substantial improvement over existing and proposed messaging systems in terms of spectral efficiency. NWN, in fact, is capable of supporting higher local message traffic than some systems designed as local systems even though NWN was intended to serve a nationwide market. Furthermore, NWN has a spectrum "cost" far lower than cell-based systems, which require at least 5 times more spectrum for rudimentary service. In other words, NWN provides significantly more public benefits than any other system existing, planned, or proposed.

V. MTEL'S NWN PORTABLES WILL BE SMALL AND LOW COST WITH EXTENSIVE BATTERY LIFE

The Mtel portables will have a maximum transmission power of 2 watts, which may be later reduced to 1 watt. PageMart, incorrectly assuming that the 7 watt mobile power limit proposed by Mtel reflected NWN design, contends that NWN portables will be large and costly with short battery life.²⁹ Seven watts, however, was only proposed as a maximum ERP for all AMS services, which, ostensibly, will include data devices in vehicles that can be powered by high current batteries. As discussed extensively in the *Mtel Technical Feasibility Demonstration*, NWN portables are designed as small, inexpensive units with an extended battery life. Mtel's preliminary cost estimates, in fact, predict wholesale costs of \$299 per NWN portable data modem and \$380 per NWN portable data terminal. Thus, PageMart's accusations about Mtel's NWN portables are wholly unfounded.

²⁹ In this regard, PageMart's observation on the proposed NWN preamble are also misleading. *PageMart Comments* at 6. The length of the POCSAG preamble (576 bits) is *not* determined so as to maximize the reliability of the data clock synchronization or resynchronization. The preamble is determined so as to optimize battery saving operation of the pagers during the idle channel. Pagers are supposed to check the channel activity periodically, typically at 546 bit intervals. Since POCSAG can be started immediately after a pager shuts off the receiver, by the next wakening of the receiver, the preamble would still be on for at least 32 bits, which is sufficient for bit synchronization. The NWN system is a synchronous network, where the next cycle header is precisely scheduled, so that the receiver can be enabled by the internal clock exactly at the onset of the preamble. The tolerance in timing is expected to be less than one digit interval. State-of-the-art clock circuits can adjust bit synchronization with less than 10 signal transitions (*e.g.*, digital PLL). As a safety margin, NWN has increased the preamble to 16 digit intervals. Since each digit carries 8 bits of information the bit length of the preamble can be expressed as $16 \times 8 = 128$ bits.

In addition, PageMart notes that "although interleaving is better suited for handling burst error, it is roughly equivalent in random error." *Id.* Burst errors are crucial since they occur when a portable device moves through the Rayleigh fading valley at moderate speed (less than 20 mph) or due to impulse noise. Therefore, the improvement, as compared to POCSAG, is significant.

VI. MTEL'S NWN SERVICE CANNOT BE ACCOMMODATED THROUGH EXISTING SPECTRUM OR SERVICES

NWN provides an inexpensive nationwide mobile communications solution for store and forward compatible computer applications. NWN is unlike any other data service, because it is designed from the outset to offer inexpensive nationwide messaging. NWN provides the numerous data communications users who do not require real-time, radio-based circuit services (whether physical or virtual) an economic and efficient messaging service that optimizes the use of the radio channel.³⁰ NWN also provides nationwide ubiquity, enhancing local real-time wireless data services much the way that SkyTel™'s nationwide paging service complements local wireless voice services. And, NWN has been designed from the ground up to optimize delivery of electronic data to satisfy these needs -- it is not an attempt to shoehorn other mobile communications technologies into an advanced messaging mold.

PageMart and PageNet, however, have criticized the functionality of NWN. PageNet argues, for example, that such enhancements are already available in SMR or cellular systems.³¹ PageNet's arguments, however, fail to recognize that NWN is intended to offer low-cost messaging on a nationwide basis to low-cost devices. Existing systems, like cellular data or SMR systems, are largely targeted at real-time applications requiring virtual voice or

³⁰ Given the growing popularity of e-mail and packet-based networks in the "wired" world, Mtel expects extensive demand for NWN, which operates in a portable radio environment. In contrast to store-and-forward services, virtual circuit real time applications demand much more intensive arrangements such as the selection of a channel pair in a trunked mobile radio system.

³¹ *PageNet Comments* at 13. PageNet also offers the entirely insupportable assertion that NWN should be implemented in the 220-222 MHz band. *Id.* NWN relies on a single 50 kHz channel in order to allow the use of enhanced multitone modulations. These techniques are simply not feasible in a narrowband 5 kHz channel.

data circuits. Mtel, in fact, views NWN as complementary to services offered by these carriers.

PageMart, for its part, has criticized NWN as being unable to transmit extended messages or facsimiles. In point of fact, NWN will support extended message lengths and facsimile messaging. Mtel's demand estimates, however, reflected shorter message lengths because Mtel's market research indicated that most users *wanted* to transmit shorter messages. Initial demand studies performed by Arthur D. Little, Inc. ("ADL") confirm Mtel's research, and indicate that users will utilize the landline network or other data transmission means when they desire to transfer files or extremely long messages.³²

PageMart's argument about facsimile messaging is also not well taken. Mtel realized initially that facsimile machines are desirable input/output devices for messaging applications, but typically are extremely inefficient -- Mtel's estimates indicate that a facsimile page is at least 60,000 bytes. Under these circumstances, it becomes extremely spectrum inefficient to transmit such messages as raw bit streams to be reconstructed at the portable. A far more efficient approach, and the one that will be used by Mtel, recognizes that the large majority of all information content in a facsimile is alphanumeric. As discussed in the *Mtel Technical Feasibility Demonstration*,³³ Mtel will use optical character recognition technology³⁴ to translate input from facsimile machines into actual characters for transmission, which has the

³² Exhibit A at 3.

³³ *Mtel Technical Feasibility Demonstration* at E24.

³⁴ The use of OCR technology to translate from written text to alphanumerics is well known, although generally not done because the costs are too high for individual users. In the case of NWN, which utilizes centralized message collection, the costs of obtaining state-of-the-art OCR technology are readily manageable.

added benefit of allowing the end user to manipulate the data upon receipt.³⁵ In this manner, the spectrum requirements of facsimile transfer are minimized even though the entire informational content is preserved. In those rare cases where graphical information must be preserved and transmitted, Mtel's NWN system is capable of transferring facsimile compatible bit-maps.

Finally, PageMart and PageNet's assertions that NWN can be accommodated through existing nationwide paging allocations or new 220 MHz spectrum is plainly wrong. Existing paging frequencies have 25 kHz channel assignments that cannot support NWN's two-way characteristics. The 220 MHz frequencies, on the other hand, have even smaller channelization. Neither is a realistic home for NWN.

VII. MTEL WARRANTS A NATIONWIDE PREFERENCE BECAUSE THE NWN SERVICE IS INHERENTLY NATIONWIDE IN SCOPE

NWN is designed as a nationwide service and a pioneer's preference should be awarded to Mtel for a nationwide license. In the *Pioneer Preference Order*, the Commission indicated that it would consider granting such nationwide preferences "[w]here a service is inherently nationwide."³⁶ NWN fits the Commission's criteria, since attempting to license NWN providers on anything less than a nationwide scale will severely compromise the utility

³⁵ Transmitting portable originated messages from the Network Operations Center to facsimile machines on the landline network is even easier; inexpensive modem/fax circuits are able to directly translate alphanumeric text into G3 facsimiles for relay to a recipient's fax machine. This sort of delivery is commonly available now through wireline e-mail providers such as MCI and Compuserve.

³⁶ *Pioneer's Preference Order*, 6 FCC Rcd at 3495.

of the service. Accordingly, Mtel requests the Commission to grant it a nationwide pioneer's preference.

As an initial matter, NWN has been designed to respond to demand for nationwide messaging.³⁷ For the projected 2.73 million mobile communications users in 1995 whose occupations demand frequent intercity travel, local and regional coverage is less than optimal. In fact, an ADL study indicates that for intercity travellers (12 or more trips in the past year) in the D.C.-to-Boston corridor, "the totality of trips . . . is greater *outside* of the Northeast corridor than it is within the corridor, thereby suggesting that regional service alone cannot meet user needs for communications when they are mobile."³⁸ This point was reaffirmed by potential customers contacted in focus group discussions conducted by A.D. Little, who noted that "a nationwide offering [was] the only option which could effectively address the totality of their messaging requirements."³⁹ ADL offered the following working hypotheses from its initial research that it will test in a further exhaustive study:

- 1) Over the next few years NWN offerings have the potential to garner a significant share of an addressable market of 2.7 million users;

³⁷ The utility of nationwide services has been recognized by both the Commission and the consumer public. In both the proceeding to allocate the 220-222 MHz band for narrowband private land mobile providers and the proceeding to allocate 931-932 MHz for common carrier paging providers, the Commission reserved channels exclusively for nationwide service. *See Amendment of Part 90 of the Commission's Rules to Provide for the Use of the 220-222 MHz Band by the Private Land Mobile Radio Services*, 3 FCC Rcd 5287 (1988), *recon. denied*, 4 FCC Rcd 6407, 6408 (1989); *Amendment of Parts 2 and 22 of the Commission's Rules to Allocate Spectrum in the 928-941 MHz Band and to Establish Other Rules, Policies, and Procedures for One-Way Paging Stations in the Domestic Public Land Mobile Radio Service*, First Report and Order, 89 F.C.C.2d 1337 (1982). Industry estimates, in addition, place the demand for nationwide paging at 870,000 subscribers by 1995. Donaldson, Lufkin & Jenrette, Company Analysis of Mobile Telecommunication Technologies, June 19, 1990, at 5.

³⁸ Arthur D. Little, Inc., "Preliminary Views of Demand for a Nationwide Wireless Network Offering" at 2-3 (Attached as Exhibit A).

³⁹ *Id.* at 3.

- 2) Nationwide rather than regional or local services are likely to be preferred by business travelers and by those who use laptop/palm top PCs and electronic organizers; and
- 3) Mobile messaging activity is likely to involve relatively short messages (one or two pages of about 2,000 bytes each) rather than file transfers of more lengthy documents.⁴⁰

In meeting this demand, NWN service cannot feasibly be provided on less than a nationwide basis since imposing geographical constraints will create vast "unserved" areas between carriers. These exclusion zones between service areas will be vast because NWN operates as a single simplex channel using a dynamic time division scheme to alternate between high power forward channel and low power reverse channel operation.⁴¹ Thus, if an adjacent co-channel system were in the forward subcycle while a neighboring system was in the reverse subcycle,⁴² the base stations would completely saturate the receiver network unless exorbitant separation criteria were adopted.⁴³ A single nationwide licensee, on the other hand, is able to control such interference and achieve virtually ubiquitous coverage by synchronizing adjacent transmitters, judiciously selecting where to locate overlap areas

⁴⁰ *Id.*

⁴¹ Accordingly, adjacent NWN carriers would not have flexibility to alter frequency plans to accommodate other providers on the same frequency block within a "coordination contour," much less the ability to deal with service contour overlap.

⁴² In theory, adjacent systems could coordinate forward and reverse channel timing, but such coordination would have other effects on NWN service. For example, the ADFM scheme would have to coordinate between two providers to alter the forward and reverse channel time mix, with impacts on the ability of the system to accommodate variations in traffic loading. As NWN becomes more mature, daisy chained adjacencies would require a single, nationwide standard for timing as more and more systems were coordinated.

⁴³ In the cellular service for base stations at 500 feet HAAT or less, where transmitters are limited to 500 Watts ERP at 500 feet HAAT, the coordination contour is 75 miles. *See* 47 C.F.R. § 22.905 (1991). For NWN service, where transmitters can utilize up to 3500 Watts ERP, the distance obviously would be much greater at the higher antenna heights.

subject to potential interference, and by use of an innovative dynamic zone allocation technique.

Even if forward/reverse coordination were to be mandated between adjacent carriers, any geographical division of NWN service would still create "edge effects" that would disrupt operation due to the complexity of NWN scheduling.⁴⁴ A nationwide NWN system, for example, has valuable nationwide time slots that are uniformly simulcasted by all transmitters across the country, a feature that could not be replicated by aggregating regional system. These few, but highly valuable, slots form an integral part of NWN by allowing the system to identify the location of any particular user terminal. If Mtel were unable to locate users with a high degree of certainty, NWN's ability to zone for additional capacity would be severely hindered and Mtel would be unable to rely upon acknowledgements as a form of registration.

In addition, Mtel's adaptive registration technique for increasing spectrum efficiency depends upon the system being nationwide. Adaptive registration promotes spectrum efficiency by reducing the use of the nationwide time slot to solicit registrations and thereby will allow Mtel's NWN service to obtain greater capacity from the valuable nationwide spectrum resource.

Other problems would occur for reverse channel transmissions. A user terminal data transfer from an interference zone might or might not be captured by a receiver managed by the terminal's home system, and therefore adjacent providers would be required to exchange data to coordinate reverse channel transmissions. In effect, adjacent providers would be

⁴⁴ "Edge effects" would exist along and on either side of system boundaries. The main effect would be interference over a large geographic area.